

The Impact of Optimization on Reducing Construction Costs in the Oil and Gas Sector in Dhahran, Saudi Arabia: A Case Study of Saudi Aramco's Projects

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Dedication

I dedicate this research to my late father, my mother, and my true friends.

1 Abstract

Completion of well technology is one of the most important steps in oil and gas well production. Saudi Aramco has given significant attention to this field development scheme (Radhwi et al., 2013).

Initially, directional drilling tools are used to drill the well and build the necessary curve to land on the right reservoir, where oil or gas is the main production component. During this process, while running the completion assembly, an additional step is taken to check that the tubular is free of damage to avoid any issues, which could fail the whole project and result in paying additional tangible and intangible costs, which could be avoided.

2 Introduction

Generally, well construction involves a series of operations that are directed by the lease operator, who employs the drilling contractor and third-party equipment and personnel (Saleh et al., 2014). The process of estimating and analyzing the overall cost of drilling presents new challenges and responsibilities for industry professionals. Furthermore, achieving cost-effective drilling is a key objective for the industry as it is essential for successful and sustainable drilling. By definition, sustainability includes cost as a critical factor (Agbon, 2002).

The oil industry has significantly increased worldwide drilling activities in response to the growing global demand for hydrocarbon. However, the addition of new and advanced equipment, tools, and technologies in drilling a well has led to higher costs. On the other hand, these facilities have reduced drilling time, which has contributed to lower drilling costs. Consequently, the drilling industry is faced with a cost analysis dilemma (Aggarwal & Kaldi, 2018).

Cost-effective drilling is a significant concern for the drilling industry to achieve success and sustainability (Al-Bani et al., 2007). Sustainability encompasses cost as one of its parameters. However, the current energy management sector is facing significant challenges due to the lack of proper training in managing financial sustainability. This has led to immense frustration in the industry (Oag. & Williams, 2000).

The energy management sector is facing a major problem due to the lack of appropriate training in handling financial sustainability. Despite numerous solutions being proposed, it is becoming increasingly evident that these options are not leading to a sustainable state in our drilling environment. This has caused significant frustration among stakeholders (Hossain & Al-Majed, 2015, pp. 227-247).

The main challenge was to implement the preferred optimization solution without a global track record. Additionally, we needed a full agreement from Aramco to trial test our new solution on their active projects, without incurring any additional costs or failures during the trial phase (Ikediashi et al., 2014).

This research aims to analyze the impact of optimization on reducing the cost of constructing wells in the oil and gas industry. It will provide a real-life example of full implementation in wells completed for Saudi Aramco, both onshore and offshore fields (Shammas, 2000).

3 Research Problem

While constructing the well, not doing the job right the first time can increase costs, which might end up suspending the whole project as it exceeds the original planned and estimated project costs and timeline (Seddeeq et al., 2019).

The research problem will address theoretical and empirical gaps.

3.1 Theoretical Gaps

The lack of understanding of the importance of fully applying optimization in drilling and completion projects on both types of projects for oil and gas resulted in blindly repeating the same process and making the same mistakes while not considering any other solution that could reduce the risk and faults of resolving the main issue, which is the integrity of the casing or tubular, while doing conventional drift operations (Abdullah et al., 2011).

3.2 Empirical Gaps

The shortage of research shows the time and cost savings of applying new techniques to consider and recognize operational problems without waiting to run the checkout equipment at the end of the job, which can result in double the cost of the whole project once repeated due to the late discovery of problems in casing or tubulars, and which can affect the next phase of drilling or completion for the same project.

4 Research Significant

The importance of the theoretical and empirical aspects of this research is to close the gaps as well as improve the use of optimization in drilling and completion projects in both the oil and gas industries (Solares, 2001).

This search aims to conclude the following:

Optimization can improve budget utilization and planning for oil & gas projects, and by adopting a cost-conscious approach, further savings can be achieved in these projects.

4.1 Theoretical Significant

This research will result in the development of a new operational plan and procedure that will help to improve the total process of doing the planned jobs and applications for Saudi Aramco by helping to identify any bad joints in either casing or tubulars before it is too late by applying an immediate inspection to all the joints without interrupting the normal operations of running in holes.

4.2 Empirical Significant

By applying a single example of optimization, the drilling and completion operations can run smoothly while meeting both the cost and timelines of the oil and gas drilling program, which results in significant time and cost savings by discovering any problems ahead of time and with no additional risk at all. Additionally, to complete all the needed and planned steps in a total health- and safety-risk-free working environment.

5 Main Research Question

Based on all the above, this research will answer the below question:

“How can we reduce the cost of well construction for both oil and gas projects by implementing an optimization technique that can discover any problem at the early stage while ensuring successful operation without additional risk or cost beyond budget?”

6 Main Research Sub-Questions

- What impact does optimization have on the economy of oil and gas operations?
- How does empowerment affect budgets and the economy when optimizations are applied?
- What is the effect of adopting a cost-conscious approach for the entire process of oil and gas operations while applying optimizations?

7 Research Objectives

The general objective is to explore the relationship between cost reduction and optimization techniques in the oil and gas projects in Saudi Aramco.

The sub objectives will be:

- Identifying the effect of optimization in the oil and gas industry.
- Identifying the effect of optimization on the budget and economy of the oil and gas projects.
- Identifying the effect of applying optimization techniques on the cost-consciousness of oil and gas projects.

8 Research Hypotheses

8.1 Main hypothesis H1:

- There is a significant correlation between optimizing the process of constructing oil and gas projects and reducing their costs.

8.2 The first sub-hypothesis Ha:

- There is a significant correlation between optimization and budget savings in oil and gas investment projects.

8.3 The second sub-hypothesis Hb:

- There is a statistically significant relationship between optimization in the process of oil and gas projects and cost-consciousness.

8.4 The third sub-hypothesis Hc:

- There is a significant relationship between optimizing the techniques of oil and gas projects and reducing their costs.

9 Research Model

The following figure shows the relationship between the research variables and the research hypotheses as follows:

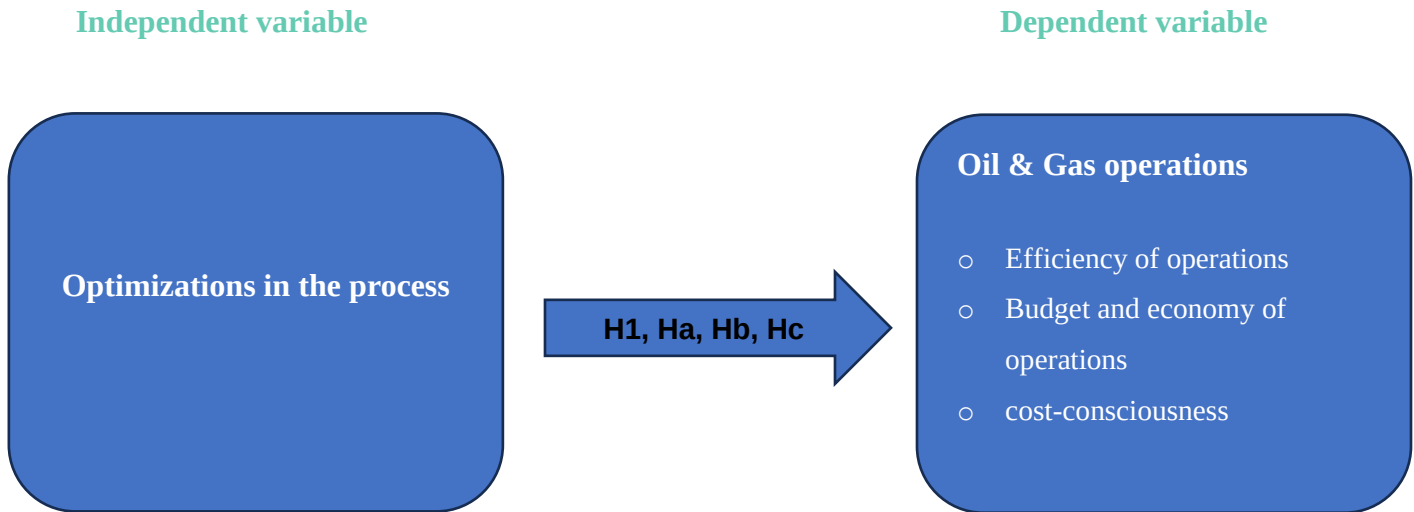


Figure 1: Proposed Research Model (The Researcher, 2024)

10 Research Proposed Location

This research will be conducted in Dhahran, which is a city situated in the Eastern Province of Saudi Arabia. It serves as a significant administrative hub for the country's oil industry. For the past 90 years, Dhahran has been the headquarters of Saudi Aramco and is also the largest gated compound owned by the company (Khorsheed, 2015).

11 Research Methodology

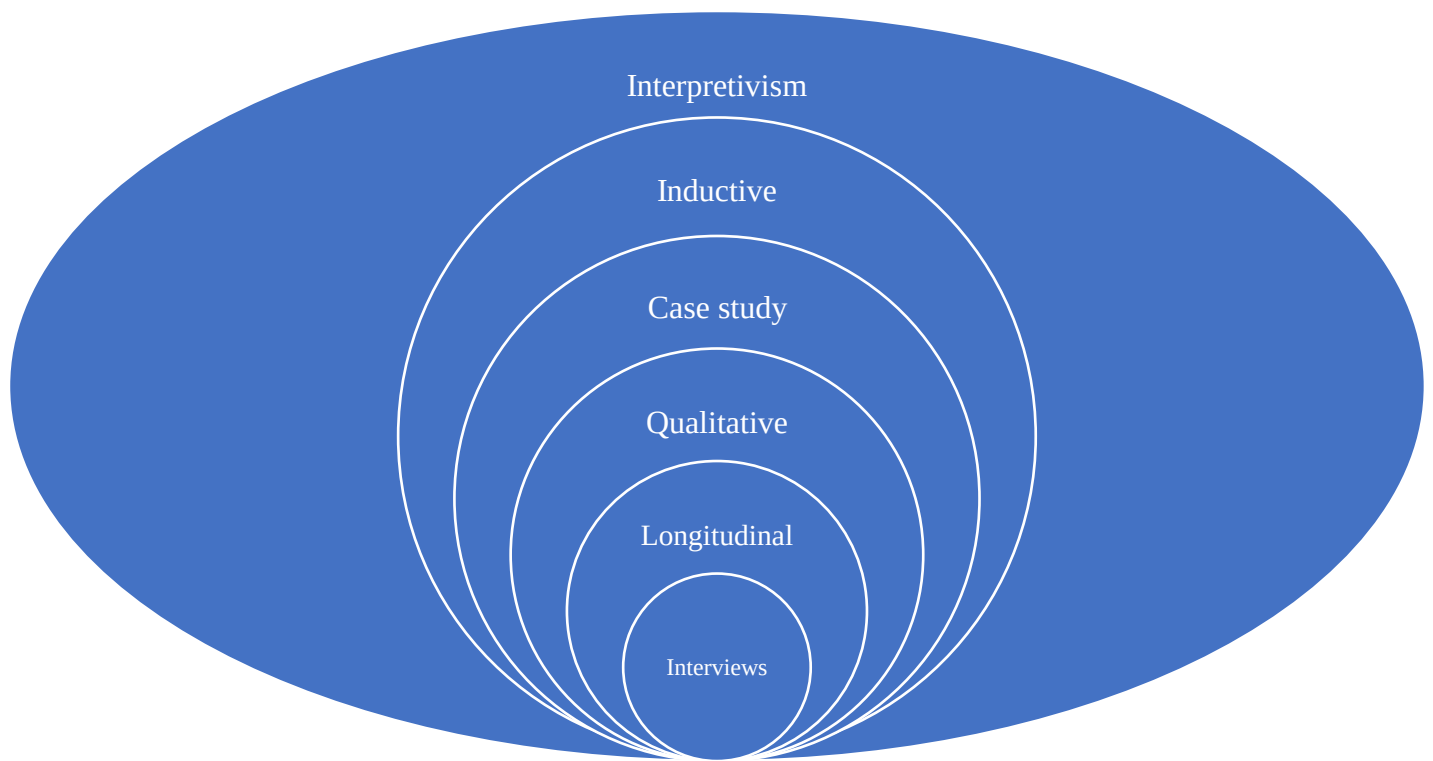


Figure 2: Proposed Research Methodology (The Researcher, 2024)

12 Suggested Research Structure

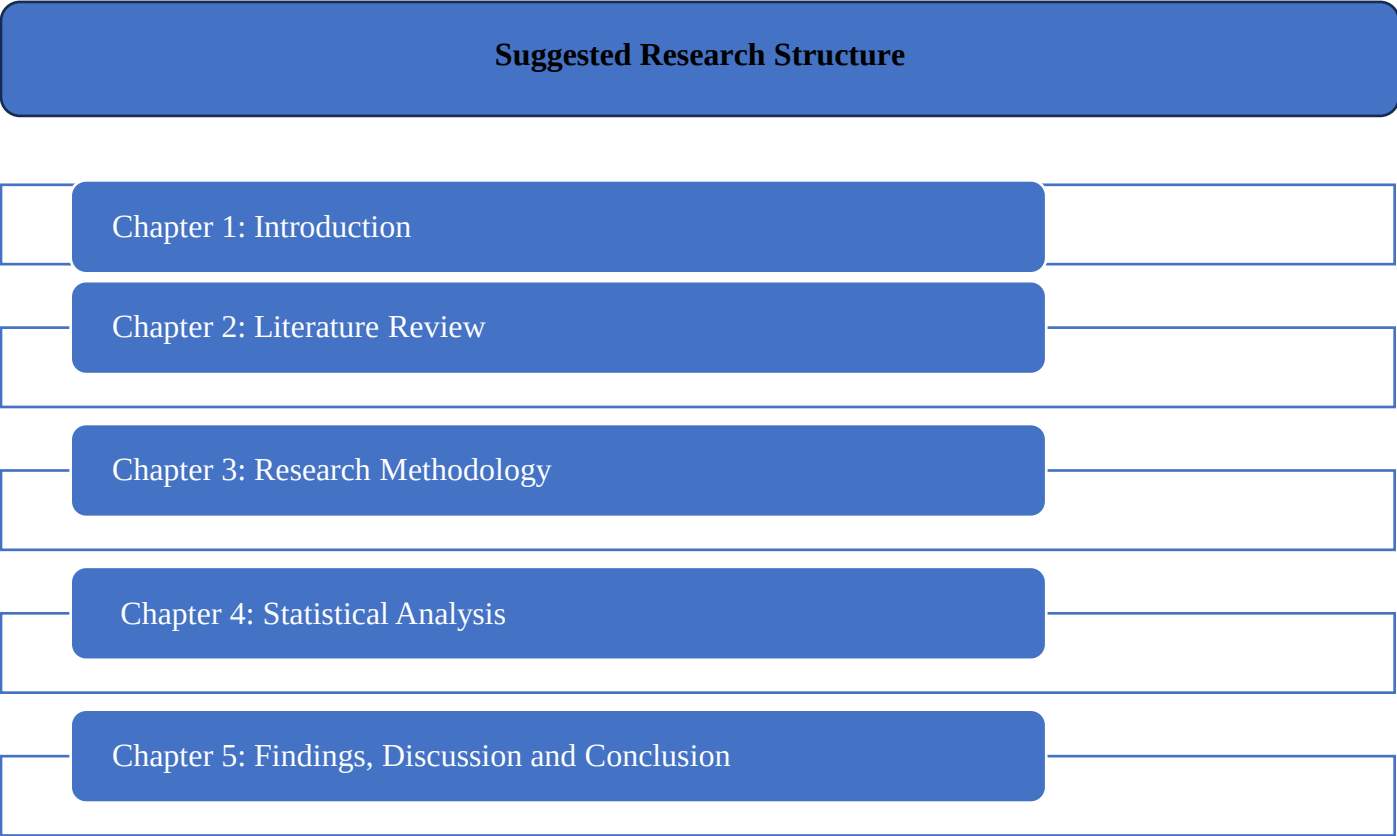


Figure 3: Suggested Research Structure (The Researcher, 2024)

13 Literature Review-First Variable: Efficiency of Operations

13.1 Introduction

Why is operational efficiency important?

A business's operations encompass all the activities it undertakes to create products or services. Inefficient operations can lead to wastage of money and effort (Mohamed Khodja et al., 2010, pp. 227-247). On the other hand, efficient operations are cost-effective as they reduce waste while maintaining quality and service standards.

13.2 Definition

Operational efficiency can be defined as the relationship between the output and input of an organization is vital for businesses to thrive. When it is healthy, it can help them to reduce unnecessary costs while increasing revenue. Essentially, businesses aim to produce high-quality products on a large scale with minimal resources.

13.3 Development

Generally Streamlining base operations, eliminating redundancy and waste, and optimizing resource utilization, production, inventory, and distribution, can improve a company's operational efficiency (Khodja & Bergaya, 2010).

13.4 Theories

Researches presents two theories: the Theory of Swift, Even Flow, and the Theory of Performance Frontiers. These theories address cross-operational productivity differences and multiple dimensions of oil and gas performance, respectively.

13.5 Dimensions

Operational efficiency is the measure of how well an oil and gas company manages its internal processes to improve the performance of its oil and gas customers. It is evaluated based on the business's flexibility, consistency, productivity, and cycle time. Flexibility refers to a company's ability to adapt to changing business conditions and meet customers' immediate and long-term needs (Muñoz et al., 2016).

13.6 Explanations

The People, Process, and Technology (PPT) framework is a comprehensive approach that companies can use to create a balanced and coordinated system that effectively supports their business operations and change management initiatives. The framework emphasizes the importance of ensuring that people, processes, and technology work together in harmony to achieve successful outcomes. If one of these elements is weak or not aligned with the others, it can negatively impact the overall effectiveness and efficiency of the business. The objective is to create synergy among all three components, leading to improved business outcomes.

Although the PPT framework is typically applied to project management and change management initiatives, it can be used to assess and optimize all aspects of a company's operations, including setting targets, managing risks, and pivoting strategies.



Figure 4: Three Pillars for c (Mustafa et al., 2021)

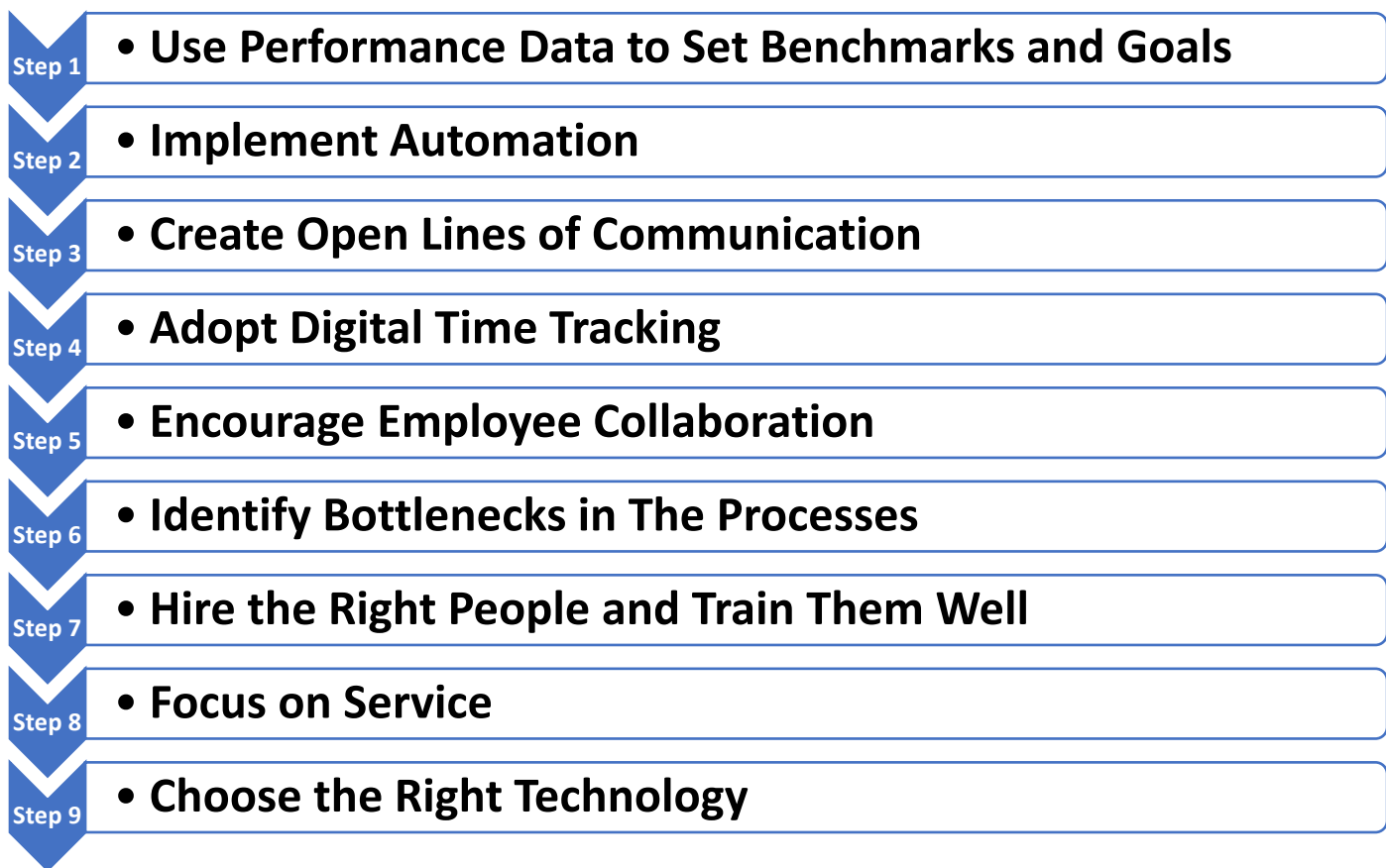


Figure 5: 9-Steps to Improve Operational Efficiency (Brett & Millheim, 1986)

- Use Performance Data to Set Benchmarks and Goals:

One effective way to engage your staff in enhancing your business's efficiency is by setting SMART goals that are specific, measurable, achievable, relevant, and time-bound. Moreover, it's important to establish methods of celebrating when those goals are either met or exceeded.

- Implement Automation:

Automating repetitive tasks maximizes staff efficiency and allows the project team to focus on critical duties.

By implementing suitable automation tools, the project manager can enhance the value of the time spent by his team. This is because the team can focus on responsibilities that truly require their skills and expertise. Automating repetitive tasks will also help to keep the project team more engaged by freeing up their schedules from mundane tasks.

- Create Open Lines of Communication:

One way to show the project team that the project manager values and appreciates them is by implementing automation. However, providing additional support efforts can go a long way in improving the company culture, enhancing staff performance, and keeping your team motivated and invested in the business. Effective communication is also essential to ensure that team members are not overwhelmed with tasks that they are unable to handle or complete on time.

- Adopt Digital Time Tracking

Digital time tracking enables project managers to analyze their staff's time usage thoroughly, identifying tasks where employees spend excessive time.

- Encourage Employee Collaboration

Encouraging project team members to communicate and collaborate with one another can lay the foundation for discussing process improvements that lead to more efficient business operations. Working together, employees can find innovative solutions to challenges. You might be surprised by the ideas and innovative thinking that result from such collaboration.

To foster collaboration, project and staff management teams can implement regular meetings or calls, use team-building strategies, and focus on developing a company culture that promotes a collaborative work environment.

- Identify Bottlenecks in The Processes

As the project manager focuses on enhancing the efficiency of the business, it's essential to evaluate how the business operates as a whole. There may likely be bottlenecks in multiple processes, which may hinder your productivity. Identifying bottlenecks can be challenging, especially if the project manager is not familiar with the processes. In such cases, it's advisable to communicate with the team and request them to identify areas that need improvement. Afterward, work with the team to come up with the necessary resources to improve the processes.

- Hire the Right People and Train Them Well

Improving operational efficiency can help maximize productivity, especially when working with a limited staff. However, it's crucial to ensure that the project manager has the right team members with the necessary skills. Employees who lack the required skill sets for their respective roles can slow down the team's progress and drain resources. By adding a key staff member, you can often increase a project's productivity, giving the existing team the additional support needed to succeed.

- Focus on Service

The project service team can boost sales, upsell products and services, and retain clients, provided they possess the necessary knowledge, skills, and tools.

- Choose the Right Technology:

Choosing the right technology is arguably the most important decision.

14 Literature Review-Second Variable: Budget and Economy of Operations

14.1 Introduction

The Oil and Gas Project Budget is a crucial tool used by project managers to determine the total cost of a project. A project budget template includes a detailed estimate of all costs that are likely to be incurred before the project is completed. Large commercial projects can have project budgets that are several pages long.

14.2 Definition

An operating budget is a detailed projection of a oil and gas company's expected revenue and expenses over a specific time period, often a year or the project life cycle.

14.3 Development

The operating budget for oil and gas is created and approved yearly, or prior to commencing any project. This budget is then compared to actual results throughout the year or the lifespan of the project to assess progress toward the organization's financial goals. The budget should include expected revenues and various types of expenses, which may incorporate fixed, variable, and one-time costs.

14.4 Theories

There are two methods to calculate the operational budget for oil and gas projects (Bianca Sarbu, 2011), which are:

- a. $\text{Operating Costs} = \text{Direct Production Costs} + \text{Fixed Charges} + \text{Asset Overhead Costs}.$
- b. $\text{Total Opex (or Total Production Cost)} = \text{Operating Costs} + \text{General Expenses}$

14.5 Dimensions

The operating budget primarily consists of sales budget, production budget, and cash budget (both cash receipt and cash payment budget). Of the components of the operating budget.

14.6 Explanations

CCH Tagetik empowers the oil and gas industry to comprehend the effects of market fluctuations, capital investments, and labor costs while forecasting profitability, regardless of the emerging scenario.

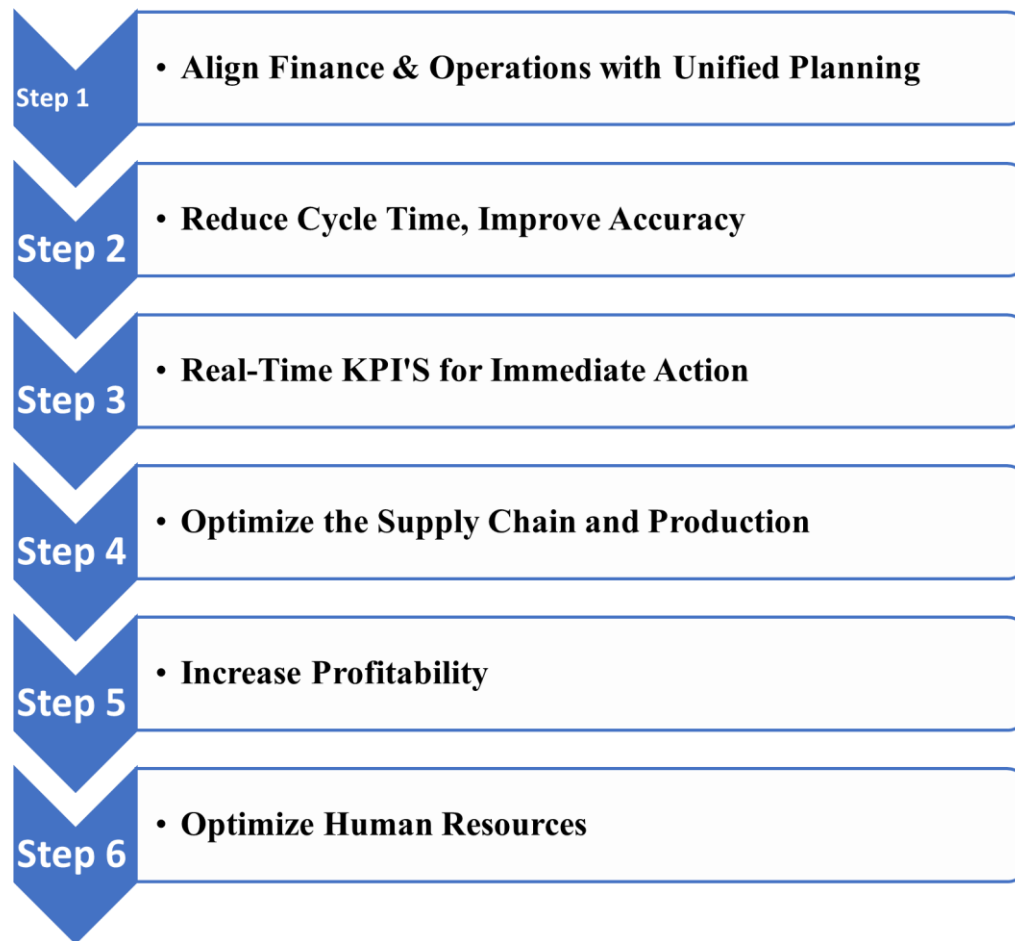


Figure 6: CCH Tagetik Planning for Oil and Gas Projects (Alnahash et al., 2020)



Figure 7: Key Benefits of Economic Budgeting in Projects (Ahmed et al., 2007)

The primary benefits of implementing economic budgeting in projects can be summarized into key points.

- Reduce Planning Cycle Time
- Optimize Resources
- Align Finance & Operations
- Increase Accuracy, Efficiency & Control
- Reduce Risk
- Lower Total Cost of Ownership (TCO)
- Modernize Finance Technology

In addition to forecasting, which represents an undeniable advantage of the budget, using budgeting in enterprise management has many benefits, including communication, coordination, authority, responsibility, mobilization, motivation, and support in decision-making.

15 Literature Review-Third Variable: Cost-Consciousness

15.1 Introduction

The awareness and attitude of project team members towards efficient resource use, waste minimization, and expense reduction are crucial for successful project management. It is essential that all members of an organization understand the significance of cost and its implications for organizational efficiency. A cost-conscious approach to cost management can be an effective method for achieving this (Oag & Williams, 2000).

15.2 Definition

Is the oil and gas project team members' awareness and attitude towards efficient resource use and minimizing waste and expenses.

15.3 Development

Establishing clear and achievable budget goals is crucial for developing a cost-conscious approach within your project team. By involving your team in the budget planning process, and clearly explaining the assumptions, risks, and limitations, you can foster a collective understanding of financial considerations. This will help your team work more effectively towards achieving financial goals.

15.4 Theories

The primary theory of cost consciousness is based on the assumption of 'waste not, want not'. Costs can be reduced through innovation.

15.5 Dimensions

Generally, businesses incur two types of costs: fixed and variable. Fixed costs, also known as overhead costs, remain constant regardless of output, while variable costs vary with output.

15.6 Explanations

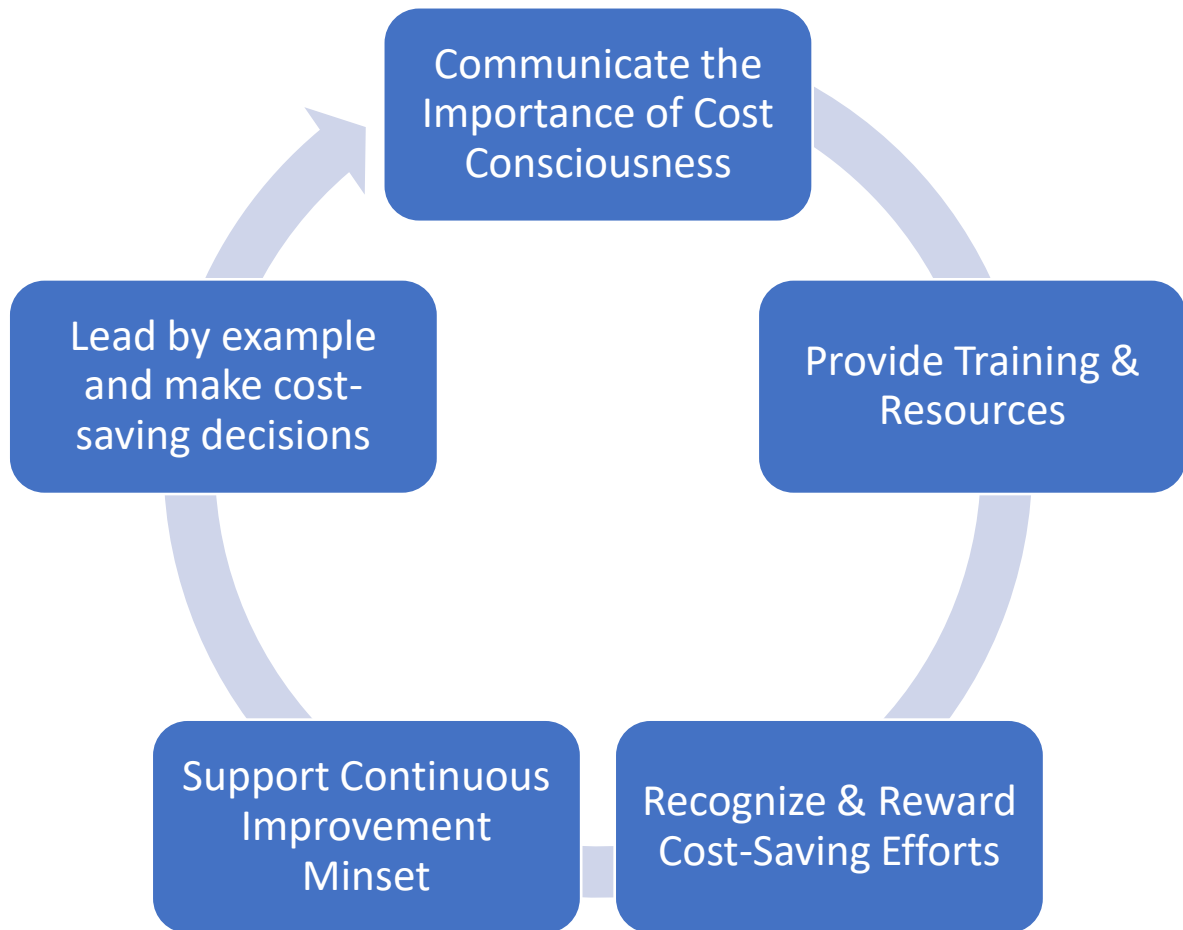


Figure 8: Culture of Cost Consciousness (Jenkins & Crockford, 1975)

Equipping the team with the necessary tools, training, and resources to make cost-effective decisions, diving into data, encouraging innovation, and resetting performance management are key elements of a cost-conscious culture.

16 The Relationship Between Variables from Previous Studies

The three variables, Efficiency of Operations, Budget, and Economy of Operations and Cost-Consciousness are interrelated in a positive way. This relationship is reflected positively in any project, specifically those that require huge resource input and result in high output. These projects do not just impact a small group of individuals, but also the economy of countries, as well as international investors who invest billions of dollars in global oil and gas projects.

16.1 Patterns

After summarizing all the studies conducted in the same field, specifically in the oil and gas industry, we can conclude that implementing optimization in the right way and addressing all relevant subjects during the planning phase of any project leads to the following positive outcomes:

- The efficiency of operations increases and can be monitored clearly.
- Budget and economic observations are used wisely, eliminating unnecessary wasteful investments in operations. This can be achieved by either replacing unneeded resources with more economically feasible solutions or by involving new solutions that will improve budget studies for oil and gas projects.

The project team, project managers, stakeholders, and investors will have an increased knowledge of cost consciousness, leading to better decision-making and minimum conflicts in a positive and supportive way (Lukawski et al., 2014).

16.2 Conflicts

Through a thorough examination and resolution of the variables listed above, we can ensure that any conflicts arising will be minimized, leading to increased success in the project. This will result in substantial savings in terms of resources and time, as the total planned days will be reduced to a minimum in the most efficient and cost-effective way possible.

It is important to note that conflicts between variables can arise if the pre-project planning is not given enough importance, and if corrective action is not taken in a timely manner during project monitoring and post-job evaluations. This can lead to delays in correcting the course of the project, which will be evident if stakeholders are not given routine feedback during the project life cycle. In addition, the involvement of outside resources, such as global economic decision-making processes,

level of experience, global logistics cost, and manpower supply, are crucial to the success of any project, particularly oil and gas projects in upstream, midstream, or downstream investment projects.

16.3 Gaps

After reviewing several studies on the relationship between optimization and three variables, including Efficiency of Operations, Budget, and Economy of Operations and Cost-Consciousness, it was observed that most studies only covered the relationship between optimization and one of these variables, instead of examining all three together. This was particularly true for research studies related to projects in general or to the oil and gas industry.

This observation has piqued my interest in writing a research paper that examines the relationship between optimization and all three dependent variables in the oil and gas industry. Specifically, I plan to focus on ongoing projects related to the Saudi Aramco working environment for oil and gas projects, whether they have been completed, are ongoing, or are planned for the future (AbdulKarim et al., 2010).

By demonstrating the positive impact of optimization on all three dependent variables, including Efficiency of Operations, Budget, and Economy of Operations and Cost-Consciousness, we can fill the gap in the research and provide a more comprehensive understanding of the benefits of optimization in the oil and gas industry. This research will be applicable to upstream, midstream, and downstream projects in the industry.

16.4 Conclusion

After studying and analyzing optimization, we can conclude that it has a direct positive relationship with improving the efficiency and economy of operations, cost-consciousness, and budget. This improvement can be observed in any projects related to the oil and gas working environment, including projects completed under the supervision of Saudi Aramco. Throughout the upcoming semester, we will apply our studies and knowledge to real-life examples from the field. We look forward to continuing our research under her direct supervision and the team at Midocean University in the next phase.

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